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METHODS DEVELOPMENT FOR ENVIRONMENTAL CONTROL BENEFITS ASSESSMENT

Volume III

FIVE STUDIES ON NON-MARKET VALUATION TECHNIQUES

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OTHER VOLUMES IN THIS SERIES

Volume 1, Measuring the Benefits of Clean Air and Water, EPA-230-12-85-019.

This volume is a nontechnical report summarizing recent research for EPA on methods development for better estimates of economic benefits from environmental improvement. The report presents the basic economic concepts and research methods underlying benefits estimation as well as a number of case studies, including several fran other volumes of this series. Finally, it offers insights regarding the quantitative benefits of environmental improvement.

Volume 2, Six Studies of Health Benefits from Air Pollution Control, EPA-230-12-85-020.

This volume contains six statistical epidemiology studies. They show that large associations between health and current levels of air pollution are not robust with respect to the statistical model specification either for mortality or morbidity. They also find that significant relationships, mostly small, occasionally appear.

Volume 4, Measuring the Benefits of Air Quality Changes in the San Francisco Bay Area: Property Value and Contingent Valuation Studies, EPA-230-12-85-022.

This volume replicates a property value study conducted in the Los Angeles Basin for the San Francisco Bay area. A taxonomy series of air quality types and socioeconomic typoligies are defined for cities in the area to examine how property values vary with pollution levels. The contingent valuation method surveys individuals, directly asking their willingness to pay for changes in air quality. The survey method yields benefit values that are about half the property value benefits in both the Bay area and Los Angeles.

Volume 5, Measuring Household Soiling Damages from Suspended Particulate: A Methodological Inquiry, EPA 230-12-85-023.

This volume estimates the benefits of reducing particulate matter levels by examining the reduced costs of household cleaning. The analysis considers the reduced frequency of cleaning for households that clean themselves or hire a cleaning service. These estimates were compared with willingness to pay estimates for total elimination of air pollutants in several U.S. cities. The report concludes that the willingness-to-pay approach to estimate particulate-related household soiling damages is not feasible.

Volume 6, The Value of Air Pollution Damages to Agricultural Activities in Southern California, EPA-230-12-85-024.

This volume contains three papers that address the economic implications of air pollution-induced output, input pricing, cropping, and location pattern adjustments for Southern California agriculture. The first paper estimates the economic losses to fourteen highly valued vegetable and field crops due to pollution. The second estimates earnings losses to field workers exposed to oxidants. The last uses an econometric model to measure the reduction of economic surpluses in Southern California due to oxidants.

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Volume 7, Methods Development for Assessing Acid Deposition Control Benefits, EPA-230-12-85-025. . . .

This volume suggests types of natural science research that would be most useful to the economist faced with the task of assessing the economic benefits of controlling acid precipitation. Part of the report is devoted to development of a resource allocation process framework for explaining the behavior of ecosystems that can be integrated into a benefit/cost analysis, addressing diversity and stability.

Volume 8, The Benefits of Preserving Visibility in the National Parklands of the Southwest, EPA-230-12-85-026.

This volume examines the willingness-to-pay responses of individuals surveyed in several U.S. cities for visibility improvements or preservation in several National Parks. The respondents were asked to state their willingness to pay in the form of higher utility bills to prevent visibility deterioration. The sampled responses were extrapolated to the entire U.S. to estimate the national benefits of visibility preservation.

Volume 9, Evaluation of Decision Models for Environmental Management, EPA-230-12-85-027.

This volume discusses how EPA can use decision models to achieve the proper role of the government in a market economy. The report recanmends three models useful for environmental management with a focus on those that allow for a consideration of all tradeoffs.

Volume 10, Executive Summary, EPA-230-12-85-028.

This volume summarizes the methodological and empirical findings of the series. The concensus of the empirical reports is the benefits of air pollution control appear to be sufficient to warrant current ambient air quality standards. The report indicates the greatest proportion of benefits from control resides, not in health benefits, but in aesthetic improvements, maintenance of the ecosystem for recreation, and the reduction of damages to artifacts and materials.

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This report has been reviewed by the Office of Policy Analysis, U.S. Environmental Protection Agency, and approved for publication. Mention in the text of trade names or commercial products does not constitute endorsement or recommendation for use.

FOREWORD

This volume is one of the reports prepared by research institutions under cooperative agreements with the Economic Research Program of the united states Environmental protection Agency (EPA). The purpose of the Program is to carry out economic research that will assist EPA in carrying out its mission. Until very recently, most research sponsored by the Program sought to improve the methods and data available for determining the economic benefits of pollution control, thereby assisting EPA and other Federal Agencies responsible for preparing benefit-cost analyses of programs and regulations. Such benefit-wst analyses are required as part of the Regulatory Impact Analyses mandated for most major Federal regulations by Executive Order 12291. The availability of improved methods and data will make it possible for EPA and other Agencies to determine more accurately the economic efficiency of their regulations and programs. Very recently, the scope of the Program has been expanded to include a broader range of research on increasing the economic efficiency of pollution control.

The Economic Research Program was a part of the Office of Research and Development (ORD) until early 1983, when it was transferred to what is now the Off ice of Policy, Planning and Evaluation. The cooperative agreements under which this volume was prepared were concluded while the Program was still in ORD; accordingly, ORD's important contribution should be recognized.

This volume is one of a series under the title Methods Development for Environmental Control Benefits Assessment prepared mainly under cooperative agreement R805059 with the University of Wyoming, although several of the individual volumes were completed under later cooperative agreements or under subagreements with other institutions. Each of the other volumes in the series is l isted on the f rent and back inside covers of this volume. The overall purpose of the series is to report significant research results achieved under the cooperative agreement. The purpose of the agreement was to develop improved methods for assessing environmental benefits, with emphasis on air pollution benefits. An earlier series of interim reports prepared under the same cooperative agreement was published by EPA in 1979 under the series title of Methods Development for Assessing Air Pollution Control Benefits with report numbers EPA-600/5-79-001a through 001e.

This volume contains five analytical and empirical studies of alternative techniques for valuing goods that are not marketed, with emphasis on some of the difficulties with using benefit-cost techniques in analyses of air pollution control programs and measures. These studies are important to EPA because of the importance of determining the economic benefits of air (and other) pollution control programs and measures and the present difficulties of doing so. Only by solving these cliff iculties can EPA make reliable benefit-cost estimates of the many benefits of its programs and regulations which are not goods sold in markets.

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ADS TRACT

This volume presents analytical and empirical comparisons of alternative techniques for the valuation of nonmarketed goods. The methodological base of the survey approach--directly asking individuals to reveal their preferences in a structural hypothetical market--is examined for bias, replication and validation characteristics. Upon finding in an experiment in the South Coast Air Basin that the survey approach does not appear to be bias ridden, satisfies some replication tests and was crossvalidated by the property value hedonic technique, a simplified benefit-cost analysis was conducted. The results imply that ambient air quality standards in the South Coast Air Basin are probably economically justified, though uncertainty concerning the benefit and cost calculations exists. To provide a third basis for comparison, the wage--hedonic technique--where it is assumed that higher wages must be paid, everything else held equal, to induce people to live in polluted communities, was implemented on a trial basis for the Standard Metropolitan Statistical Areas of Denver and Cleveland. The purpose was to explore if a relative low cost technique could be utilized in achieving a national benefit estimate. Given the research presented in this volume, it appears the three techniques could be utilized in constructor.g a national benefit estimate.

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CHAPTER 1

INTRODUCTION

Benefit-cost analysis is a well established mode of applied economics extensively used for the evaluation of public investment projects and most recently environmental policies. This volume deals with some of the special difficulties in the use of benefit-cost analyses in programs designed to preserve or maintain air resources. The specific task is to estimate the benefits associated with alternative levels of air quality. If benefit-cost analysis is to be employed for decisionmaking, techniques need to be devised to impute economic values for changes in the quality of air resources.

Two approaches have been proposed for measuring the value of non-market goods . The most widely accepted approach has been the use of hedonic prices, where it is assumed, for example, that either wages or housing values reflect spatial differences in the quality of air resources. Alternatively, using survey techniques, one may directly ask households or individuals to state their willingness to pay for alternative levels of visibility. The necessity for an alternative approch, to the hedonic, lies in the spatial nature of air resources. In a well developed housing market, the hedonic approach is appropriate. However, consider the case of a remote and unique scenic vista, valuable to recreators, which is threatened by air pollution from a proposed coal fired power plant, a typical situation in the western United States. Although it is possible, in principle, to impute the value of clean air and visibility from the relative decline in local visitation which might follow construction of a power plant, information on the value of visibility at the site is needed prior to construction for socially optimal decisionmaking. The hedonic approach is unavailable both because the scarcity of local population makes use of wage or property value data impossible and because scenic vistas may themselves be unique.

The empirical implementation of the survey approach, however, raised questions of bias, replicability, validation by other techniques, and appropriateness for benefit-cost analysis given the hypothetical nature of the technique. Before incorporation of survey approach results into benefit-cost analysis these questions require answers. Accordingly, the chapters that

follow address the following topical areas.

In Chapter 2--Valuing Environmental Commodities: Some Recent Experiments, we evaluate the results of six recent experiments which have utilized the survey approach for estimating a nonmarket attribute associated with the environment. Where possible, the issue of replication of results is addressed. The range of environmental attributes valued in the six experiments was quite large--noise, wildlife, strip mining, and visibility. Four out of six attempted some internal methodological cross check. Biases, within the survey approach, do not appear to be an overriding problem. However, the studies indicate the need to establish a precise market, hypothetical in nature, for the survey approach to be useful.

In Chapter 3--Valuing Public Goods: A Comparison of Survey and Hedonic Approaches, we take up the central issue of validating the survey approach. Although the results of Chapter 2 suggest the survey approach is internally consistent, replicable and consistent with demand theory, no external validation had been undertaken whereby a comparative analysis using another approach independent of the survey had been conducted. Thus, the purpose of this chapter is to report on an experiment designed to validate the survey approach by direct comparison to a hedonic property value study.

The Los Angeles metropolitan area was chosen for the experiment due to the well defined air pollution problem and because of the existence of detailed property value data. Twelve census tracts were chosen for sampling wherein 290 household interviews were conducted during March, 1978. Respondents were asked to provide their willingness to pay for an improvement in air quality at their current location. Air quality was defined as poor, fair, or good based both on maps of the region (the pollution gradient across the Los Angeles Metropolitan Area is both well defined and well understood by local residents) and on photographs of a distant vista representative of the differing air quality levels. Households in poor air quality areas were asked to value an improvement to fair air quality while those in fair areas were asked to value an improvement to good air quality. Households in good air quality areas were asked their willingness to pay for a region-wide improvement in air quality.

For comparison to the survey responses, data was obtained on 634 single family homes sales which occurred between January, 1977, and March, 1978, exclusively in the twelve communities used for the survey analysis. Households, in theory, will choose to locate along a pollution-rent gradient, paying more for homes in clean air areas based on income and tastes. However, ceteris paribus, we show that the annualized cost difference between homes in two different air quality areas (the rent differential for pollution) will in

theory exceed the annual willingness to pay for an equivalent improvement in air quality for a household in the lower air quality area. Thus, the rent differential associated with air quality improvement from hedonic analysis of the property value data must exceed estimates of household willingness to pay for the survey responses, if the survey responses are a valid measure of the value of air quality improvements. The theoretical model described predicts that survey responses will be bounded below by zero and above by rent differentials derived from the estimated hedonic rent gradient. The empirical results do not allow the rejection of either of the two hypotheses, thereby providing evidence towards the validity of survey methods as a means of determining the value of nonmarket goods.

In Chapter 4--The Advantage of Contingent Valuation Methods for Benefit-Cost Analysis, we address why the survey approach is especially useful in providing information to be utilized in environmental decisions. The chapter is taxonomic in nature discussing why survey methods may often be a superior means of generating data with which to value nonmarket goods. Specifically the issue of the hypothetical nature of the survey technique is addressed. We argue that within the constructs of economic theory, it is wrong to view hypothetical responses as fictional, and that the survey approach is quite often the only technique which can address future events without going through the costly exercise of actually constructing a market.

Chapter 5--An Examination of Benefits and Costs of Mobile Source Control Consistent with Achievement of Ambient Standards in the South Coast Air Basin, is an examination of the benefits and costs of the national ambient air quality standards as applied to all portions of Los Angeles, Orange, Riverside and San Bernardino Counties in southern California. The results set forth are based on the qualified arguments presented in Chapters 24 suggesting that both the survey approach and property value approach are valid techniques of benefit-cost analysis. Based upon modeling contained in the region's Air Quality Management Plan, achievement of the ambient standards in 1979 would require emission reductions of the 974 tons/day, 5963 tons/day and 503 tons/day of reactive hydrocarbons, carbon monoxide and nitrogen oxides. It is the share of these emission reductions attributable to on-road mobile source control which was evaluated using benefit-cost analysis.

Benefits were calculated through an examination of housing value differentials attributed to air quality (see Chapter 4). Achieving the ambient air quality standards was consistent with improving the "fair" and "poor" air quality regions to the "good" category as specified in Chapter 3. In effect, this constituted an approximate 30 percent improvement in the fair areas and a 45 percent improvement in the poor air quality areas. Corresponding benefits were estimated to fall between 1.6 and 3.0 billion dollars per year,

independent of any benefits accruing to agriculture and ecosystems. The share of these benefits associated with on-road mobile source control was estimated to be 1.362.55 billion dollars.

Cost estimates were developed from existing data sources, primarily from manufacturer statements and government publications. Given the variation in control cost options and the uncertain nature of the cost figures, it was found that on-road mobile source controls consistent with a policy sufficient to achieve the ambient standards in 1979 would involve a cost of between .61 and 1.32 billion dollars, with a best estimate of 1.02 billion dollars.

The benefits from on-road mobile emissions reductions consistent with satisfying the ambient standards are of the same order of magnitude as the cost estimates. This implies that the ambient air quality standards are not without some economic justification, though the uncertainty concerning the benefit and cost calculations prevents one from accepting the controls outright. However, on-road mobile controls consistent with the air quality standards cannot be rejected as economically inefficient either. Therefore, although the mid-range benefit estimate exceeds the mid-range cost estimate, the situation is best characterized as highly uncertain. Further, the static analysis performed does not answer significant questions concerning the behavior of the benefit and cost functions over time. Stronger statements could only be made in the context of a much more detailed analysis supported by a solid cost data base.

In Chapter 6--Effects of Air Pollution and Other Environmental Variables on Offered Wages--we report on some exploratory estimates of the effect of changes in air pollution levels on offered wage rates. This approach is appropriate for a national benefits study where it is assumed that higher wages must be paid, everything else held equal, to induce people to live in polluted communities.

Annual benefit estimates from pollution abatement in the two cities are positive according to the calculations made here. For Denver, meeting the national secondary standards for TSP results in a reduction in the offered real wage, from $4.1758/hr. to $3.9626/hr. Multiplying this difference of $.2136/hr. by the number of persons affected times 2000 hours yields an estimated annual benefit for Denver of $92,968,935. A similar calculation for Cleveland reveals that meeting the national secondary air quality standards causes the real wage to fall from $3.8756/hr. to $3.7693/hr. implying a benefit of $81,360,489. Note that benefits per household head in the two cities are $426.35 for Denver and $212.60 for Cleveland. This preliminary research suggests the wage hedonic technique is viable for estimating air pollution control benefits for standard metropolitan areas across the nation.

A national benefit estimate for air pollution control based on consumer perceptions as reflected in wages and property values appears possible. Further, the use of the survey approach to assess the value of perceived benefits, such as visibility improvements, not captured by wages and property values appears feasible.

Chapter 2

VALUING ENVIRONMENTAL COMMODITIES: SOME RECENT EXPERIMENTS

INTRODUCTION

During the past few years, economists have been attempting to apply a variety of techniques to reveal preferences of individuals on nonmarket environmental commodities [Bradford (1970); Bohm (1971); Randall, et al. (1974a); Brookshire, et al. (1976)]. These techniques, in general following Davis (1963), have attempted through a set of questions to obtain bids from individuals which would represent their maximum willingness to pay for a nonmarket commodity. Almost simultaneously, other economists have made substantial contributions to conceptually assessing the demand for nonmarket commodities and public goods [Rosen (1974); Muellbauer (1974); Hori (1975)]. The consumer of nonmarket commodities in these studies is viewed as a utility maximizer who combines purchase of private goods (and use of public goods), constrained by a household technology, to produce a set of desired characteristics [Lancaster (1966)]. Given this basic structure, methods were suggested for calculating implicit prices for the household characteristics and nonmarket goods used or produced by the consumer [Hori (1975)]. This paper is an assessment of six recent experiments which have attempted to reveal preferences for environmental goods, where each experiment in some way utilized a mix of both the techniques and the theory of demand for nonmarket commodities. Each experiment was designed to estimate a nonmarket attribute associated with the environment and also analyze potential biases in the techniques employed. In order to evaluate these studies, a rather general model of the consumer behavior is proposed. Potential biases are then discussed for various methods used to discover environmental preferences. Following this, the six experiments are examined on the basis of their methodological structure and types of biases encountered. Where possible, the issue of replication of results is addressed. In this paper, we do not attempt to evaluate all types of environmental effects or possible ways of measuring them. Rather, a limited set of possibilities is examined both as to technique and type of effect.[1]

Many environmental policy issues involve changes in environmental

attributes resulting from population growth and energy development. For example, operation of coal fired electric power plants may significantly reduce visibility and disturb landscapes in addition to inducing possible health effects. Strip mining coal may have substantial detrimental effects on wildlife populations in addition to the expanded demand for wildlife arising from a larger local population. The construction of geothermal plants adjacent to existing forest recreation areas may, through siting and noise, disturb an otherwise pristine, quiet recreation area. Essentially, recreational use and benefits would be changed by these developments but there are no existing markets to adequately price the changes. Similarity, population growth in some urban areas has caused significant problems with photochemical air pollution. If benefit-cost analysis is to be employed for decisionmaking, techniques need to be devised to impute economic values for these and other environmental changes. The six experiments evaluated here are tests to determine the feasibility of deriving implicit prices and/or valuations for the types of changes mentioned above.

The techniques to be examined range from purely hypothetical direct evaluations asking for dollar bids to hypothetical questions asked of households and recreators concerning changes in behavior to enable the imputing of their preferences. In each case, the household was confronted with a possible change in an environmental attribute and asked for a valuation. Since the valuation was contingent on the specific hypothetical change identified (through photographs, brochures and other means), we propose that such approaches be called contingent valuations.[2] Individuals can be queried as to willingness to pay, minimum compensation, evasive behavior, past experiences, current experiences, potential site or activity substitutions, potential expenditure adjustments, income compensation coupled with potential behavioral adjustments, etc. which can be utilized with appropriate theoretical structures to estimate demand curves for environmental attributes.

In some of the experiments, the household valued the change in environmental attribute directly by bidding for alternative provision levels [Brookshire, et al. (1976)]. In others, the individual was not only asked to bid, but also provide information on behavioral adjustments and sale of the environmental attribute [Randall, et al. (1974a); Rowe, et al. (1980); Brookshire, et al. (1980)].

To obtain accurate information for individual valuation of nonmarket environmental commodities can be costly. In many cases to actually derive true values, a "market" must be set in a place where one did not exist and operated to record prices and demands where the environmental attribute is actually purchased or sold. However, to construct and operate such a market may be extremely costly, especially if there are irreversibilities associated

with its operation. A less costly approach is to use a contingent valuation study where prices can be imputed without the actual operation of an organized market, but a hypothetical market is structured. However, because of its hypothetical nature, several potential biases may occur. The major types of biases are: (1) strategic bias whereby the individual may attempt to influence the outcome or result by not responding truthfully; (2) information bias, which is a potential set of biases induced by lack of, or type of, information given to the consumer in the contingent market; (3) instrument bias, which is bias introduced by the process or procedures employed to discover preferences; (4) hypothetical bias, which is the potential error induced by not confronting the individual with an actual situation, i.e., an organized market with well-defined prices; or sampling, interview or nonrespondent bias.[3] Clearly, asking someone what they will do or pay a priori is not the same as confronting them with a recognized and well-understood market and observing what they actually pay. It is more analogous to the individual making decisions on contingent events, e.g. , if air quality deteriorates, I will move to a cleaner community. Of the list of studies summarized herein, the list directly compares a contingent valuation study with a more traditional property value study to assess the magnitude of these potential biases and attempts to resolve the actual versus hypothetical payment question [Brookshire, d'Arge, Schulze, and Thayer (forthcoming(d))].

A THEORETICAL FRAMEWORK FOR VALUING ENVIRONMENTAL AMENITIES

The variety of empirical approaches used to value environmental amenities, whether examining contingent or actual behavior or market prices, have typically been based on a particular ad hoc theoretical structure. This section attempts to provide a common theoretical basis for the variety of approaches outlined earlier and serve as a focus in evaluating the six experiments presented in later sections. Both Freeman (1979a,b) and Maler (1974) have also examined available approaches from a consistent theoretical perspective.

A general modeling structure must include the possibility of consumer substitution across activities and locations; and must include site or activity specific levels of environmental quality. Individual utility is thus specified as a function of levels of activities, $A_1, \ldots, A_i, \ldots, A_n$; as a function of a composite commodity X, "unaffected" by activity specific environmental quality; and (where the subscripts denote different activities) as a function of environmental quality for each activity, $Q_1, \ldots, Q_i, \ldots, Q_n$, where we take increases in Q_i as increasing environmental quality. Note we can allow possibly different environmental quality levels both by varying Q_i for a specific activity A_i which can occur over many sites or by defining a site specific activity in which case different Q_i's are associated

with different sites. Utility is then a quasiconcave function,

$$U(A_1, \ldots, A_n; Q_1, \ldots, Q_n; X) \tag{1}$$

where $\partial U/\partial A_i = U^i_A > 0$, $\partial U/\partial Q_i = U^i_Q > 0$, and $\partial U/\partial X = U_X > 0$ so utility is increasing in A_i, Q_i, and X. Of course, assumptions on the separability of U are obvious, given that environmental quality is related to specific activities in the model." However, we do not pursue that issue here. Rather, we focus on the form of an individual's marginal willingness to pay for environmental quality.

The budget constraint necessary to specify the consumer's optimization problem is given as:

$$Y - \sum_{i=1}^{n} P_i A_i - X \geq 0 \tag{2}$$

or income Y minus the sum of expenditures on activities $\sum_{i=1}^{n} P_i A_i$ (P istaken as the price of activity i which may, in fact, represent joint consumption of several market commodities; for example, activities might include driving to work, recreating, shopping, etc.) minus expenditures for the composite consumption commodity X (price for X is taken as unity to simplify the analysis) must be nonnegative.

For a given vector of environmental quality, the household will then choose to allocate activities such that (1) is maximized subject to (2) which in turn implies that:

$$\frac{U^i_A}{U_X} \leq P_i, \quad \left(\frac{U^i_A}{U_X} - Pi\right) \cdot A_i = 0 \; A_i \geq 0 \quad i = 1,2, \ldots, n \tag{3}$$

or the marginal rate of substitution between activity i and the composite commodity X equals the price of activity i, if that activity is chosen ($A_i > 0$). We, of course, assume $X > 0$.

To determine the marginal willingness to pay for environmental quality for a particular activity, for example i = 1, we set utility as given in equation (1) equal to a constant and totally differentiate the resulting expression. By then taking the total differential of equation (2), setting $dQ_i = 0$ for all $i \neq 1$, $dP_i = 0$ for all i, and by using (3) we obtain

$$\frac{U_Q^1}{U_X} = -\frac{dY}{dQ_1} \qquad (4)$$

as the change in income necessary to offset a change in environmental quality for activity 1.[5] If the objective is to determine the marginal willingness to pay for environmental quality (U_Q^1/U_X), one obvious approach is to simply postulate in a survey questionnaire that Q_1 increases by a small amount dQ_1, where market prices are hypothetically held constant, and request information on the contingent willingness of the individual to give up income for an increase in quality (so dY would be negative in this case). This direct approach, however, is open to questions of bias, a topic we take up in more detail later.

A second approach is to actually assume that prices of activities do not change in response to a change in environmental quality. For many recreation situations this may well be a reasonable approximation. For example, if an energy development such as a power plant disrupts a recreation site, recreators may respond by driving further to other alternative sites. If no entrance fees are employed or if such fees are institutionally fixed, if driving costs--the price of gasoline, etc.--and prices of recreation equipment do not change, then the assumption that $dP_i = 0$ for all i appears to be a good one. In that case the marginal willingness to pay can be determined by again setting utility in equation (1) equal to a constant and totally differentiating the resulting expression, by using equation (3) and by assuming $dQ_i = 0$ for all $i \neq 1$ and that $dP_i = 0$ for all i, to obtain:

$$\frac{U_Q^1}{U_x} = -\sum_{i=1}^{n} P_i \frac{dA_i}{dQ_1} + \frac{dX}{dQ_1} \qquad (5)$$

Where prices are known, an estimate of the value of environmental quality can then be obtained empirically by collecting data on dA_i/dQ_1, the compensated change in the pattern of, for example, recreation activities in response to a change in quality, and on dX/dQ_1, the compensated change in expenditures not related to recreation activities. Note that here we assume Q_1 is tied to a specific recreation site. Of course, the change in environmental quality can be hypothetical, resulting in contingent changes in activities, or actual crosssectional or time series data can be employed where environmental quality varies over space or time. In any case, all studies to date focusing on substitution of activities or commodities in response to changes in environmental quality that we are aware of have assumed prices to be fixed.

In contrast to the above approaches, the hedonic approach, focusing on price effects of changes in environmental quality, assumes that P_1, the price

associated with A_1 and in turn Q_1, varies, but that all other prices still remain fixed. Thus, again assuming utility is constant and by totally differentiating equations (1) and (2) where $dP_i/dQ_1 = 0$ for all $i \neq 1$, using (3), we obtain:

$$\frac{U_Q^1}{U_X} = A_1 \frac{dP_1}{dQ_1} \qquad (6)$$

where we also assume $dY = 0$ since compensation is achieved at the margin through the hedonic price gradient, dP_1/dQ_1. Thus, individuals are compensated for lower levels of environmental quality by a lower price. As an example of this approach, consider a study which uses differences in property values to value air quality. Serious questions must be raised concerning the reality of the assumptions that other prices remain unchanged in response to differences in air quality. For example, if wages or golf fees vary with air quality levels, property values may not fully capture the willingness to pay for air quality. Note that in this case we assume that Q_1 is environmental quality associated with an activity or activities.

In summary, the marginal willingness to pay of consumers for environmental quality can be determined as shown in our theoretical context by three approaches. First, consumers can be directly asked to provide their marginal willingness to pay, dY/dQ_1. Second, assuming no price changes occur, information can be collected on dA_{j1}/dQ_1 and dX/dQ_1, the substitution of activities and expenditures which occurs in response to a change in environmental quality. From these data one can impute a marginal willingness to pay. Third, assuming all prices but one are invariant, the change in the single remaining price, dP_1, can be used to impute environmental benefits. Of the three approaches, the one which requires the fewest a priori assumptions and minimal data collection is the first, contingent bids derived utilizing survey instruments. However, serious questions of possible bias remain. The next section discusses possible biases in the survey questionnaire approach.

CONTINGENT VALUATION AND BIAS

Economists have argued that valuing public goods through a direct demand revealing process such as a contingent market would yield biased results. The principle theoretical support for this contention is the possibility of strategic bias. However, as survey techniques to elicit contingent behavior or bids have come into use--in part because development of energy resources in formerly pristine environments allows no other techniques to be used-- other types of bias have come to be regarded as just as important. These include information bias, instrument bias, hypothetical bias and traditional problems

of sampling, interviewer, and non-respondent bias. This section reviews our current understanding of such biases.

Strategic Bias

Beginning with Samuelson's seminal work on public goods, it has been supposed that direct revelation of consumer preferences for such goods--and, of course, environmental quality is a public good--would be impossible [Samuelson (1954)]. In particular, the free-rider problem would give individuals incentives to misstate their preferences. For example, if nearby residents were asked how much they were willing to pay to clean up the air near a power plant and if they suspected that control costs would be borne by consumers and owners elsewhere, local residents would have an incentive to overstate their willingness to pay. On the other hand, if residents suspected that they would be individually taxed an amount equal to their own willingness to pay, then a clear incentive would exist to understate their own true value, hoping that others would bid more.

Each approach for eliciting willingness to pay will potentially generate its own bias. Thus if recreators are told that the average of their bids to prevent construction of a nearby power plant will be used to set an entrance fee, those individuals who suspect their bid to be greater than the average bid will have an incentive to overstate their willingness to pay. They, in fact, have an incentive to raise the average bid as close as possible to their own true bid. In other words, individuals will have incentives to misstate their own preferences in an attempt to impose their true preferences on others. This will require a substantial amount of information to actually behave in this manner [See Brookshire and Eubanks (forthcoming (a))]. Of course, if the respondents to such a survey do not believe the survey will have any impact on policy or outcomes, then no incentives for bias exists. The hypothetical nature of such surveys may then, in actuality, aid in eliciting bids which are not strategically biased. Alternatively, since payment is not required, a tendency to exaggerate willingness to pay for a preferred outcome might also exist.

Empirical evidence thus far does not support the existence of strategic bias among consumers. Bohm (1971) in an experimental approach utilizing actual payments for public television failed to find strategic bias significantly affecting the outcome. Scherr and Babb (1975) utilized three different mechanisms for valuing public commodities and found little evidence supporting the existence of strategic bias. Smith (1977) in laboratory experiments also failed to find strategic bias "as a significant problem. The case studies to be reported in the next section, where tested for, also do not find strategic bias to be a problem.

Information Bias

Since contingent behavior or valuation is hypothetical, it is clear that answers obtained through surveys are not based on information similar to that which would apply if consumers based answers on real experiences. One is an *ex ante* response while the other is an *ex post* statement.[6] Typically, consumers do reevaluate decisions on the basis of experience and gained knowledge. Thus, an individual or household might respond to a hypothetical decrease in environmental quality at one location with a low bid, thinking that other nearby sites would make good substitutes. However, in a real situation the individual might have found that other sites involved more travel costs and were less satisfactory than imagined. The information presented to the respondent in a survey situation relating to substitution possibilities and alternative costs may well change the stated willingness to pay relative to other types of information. Thus information bias can refer to the structural content of the contingent market being different than the valuation problem at hand. That is, the respondent must be made aware of proposed alternatives in terms of quality or quantity. Other variants of information bias might include giving the respondent information as to how other respondents behaved, whether in the aggregate their bid was sufficient to achieve (or not achieve) the stated goal (i.e., possibly prevention of visibility deterioration) or alternative sequencing of questions.

Instrument Bias

Related to information bias is instrument bias whereby characteristics of the mechanism for obtaining willingness to pay possibly influence the outcome. Two characteristics of the survey bidding approach are vehicles for payment and a starting point for initiation of the bidding process. Studies have recognized that the mechanism used to collect the bid or pay compensation may influence its magnitude [Randall, et al. (1974a)]. That is, if the recreator pays a higher park entrance fee rather than another type of tax, his bid for an environmental attribute may differ. From economic theory, the bid should differ, if the price of the commodity represented by the bidding vehicle changes, provided the recreator's substitution possibilities associated with alternative payment mechanisms are different. When a payment vehicle allows the individual to substitute over a wider range of current commodities purchased, then the bid should be higher or compensation lower than where the range is smaller. Ideally, the bid or compensation should be related to adjustments in disposable income or wealth, where the individual has the greatest latitude for potential substitution. Practically, however, a believable payment mechanism related to income adjustment, in general, cannot be applied. For example, surveys are often taken at recreation sites away from the individual's locale or state. In this case, a wage tax may not be

viewed as realistically payable by the recreator. Thus, there is a tradeoff between accuracy associated with a less than ideal method of payment and the believability of the vehicle for payment or compensation. The reduction in substitution possibilities for a more believable payment mechanism is likely to reduce the contingent expenditure or increase the compensation estimate.

A second type of instrument bias is starting point bias. The contingent valuation approach commences with questions on payment (and/or compensation) for hypothetical changes in environmental attributes. Contingent bidding surveys to date have asked the recreator (or any type of interviewee) a question with a "yes" or "no" answer rather than a question requiring explicit calculations [See Randall, et al. (1974a), Brookshire, et al. (1976)]. It is presumed the recreator can more accurately respond to the yes/no question framework, although to our knowledge, this proposition has not been formally tested for individuals responding to contingent valuation questions. Given the proposition that yes/no responses are desirable, often a starting bid or minimal level of compensation has been suggested. The potential bias arises in suggesting a starting point from at least two possible sources. First, the bid itself may suggest to the individual the approximate range of "appropriate bids." Thus the individual may respond differently depending on the magnitude of the starting bid. Second, if the individual values time highly, he may become "bored" or irritated with going through a lengthy bidding process. In consequence, if the suggested starting bid is substantially different from his actual willingness to pay, the bidding process may yield inaccurate or only roughly approximate results. The effect of these two types of starting point biases may substantially influence the accuracy of contingent valuation and therefore the usefulness of this approach for assessment of environmental preferences.

Hypothetical Bias

The discussion on information bias suggested that the contingent valuation approach will give answers dependent upon the information or "state of the world" described. The contingent valuation approach requires postulating a change in environmental attributes such that it is believable to the individual and accurately depicts a potential change. The change must be fully understandable to him, i.e. , he must be able to understand most, if not all, of its ramifications. The individual also must believe that the change might occur and that his contingent valuation or behavioral changes will affect both the possibility and magnitude of change in the environmental attribute or quality. If these conditions are not fulfilled, the hypothetical nature of contingent valuation approaches will make their application utterly useless.[7] A test of hypothetical bias would require that the perturbation proposed would occur and then the respondents actual reaction would be evaluated in terms of

the previous hypothetical statements of willingness to pay. This, however, makes it extremely difficult to measure the extent of hypothetical bias within a contingent experiment since it depends not only on the structure of the experiment, but also on the "uncontrolled" factors of the future.[8]

Other Bias

Any survey approach, including the contingent valuation approach, is subject to sampling bias, non-respondent bias and interviewer bias. Any of these certainly can subject the results of an experiment to question even if all previously mentioned bias are non-existent. Given the acknowledgement of these biases, we will not discuss them in detail here given their wide recognition in the survey literature. However, in discussing the case studies in the next section, the possible existence of these biases will be discussed in each study, where the information is available.

VALUING ENVIRONMENTAL QUALITY: RECENT CASE STUDIES

There have been numerous efforts to apply a variety of techniques for valuing non-marketed goods; public television [Bohm (1971)]; land-form alterations due to strip mining [Randall, et al. (1978)]; air pollution-induced health effects [Loehman, et al. (1979)]; wildlife [Hammack and Brown (1974), Bishop and Heberlein (1979)]; water pollution [Gramlich (1977)]; presentation of river headwaters [O'Hanlen and Sinden (1978) and Sinden and Wyckoff (1976)]; urban infrastructure allocations for expenditures and taxes [Strauss and Hughes (1976) and Cummings et al. (1978)]; airplane safety [Jones-Lee (1976)]; and recreation [Davis (1963)].

This section will summarize in chronological order six studies which have in common the use of a survey technique which had its first empirical application by Randall, et al. (1974a,b). (The Randall, et al. study was the first systematic presentation and empirical implementation of the contingent bidding survey approach which set the stage for further inquiries.) Tracing the methodology development which has occurred through these six studies aids in understanding issues relating to bias problems, replication issues and methodological cross checks. The last study discussed, the South Coast Air Basin Experiment, addresses the question of validation of the contingent market approach by direct comparison of contingent results with a hedonic--market data based-study.

The Four Corners Experiment

The Four Corners Experiment [Randall, et al. (1974a,b)] represented the first empirical application of the survey approach.[9] The roots of the effort

can be traced to Davis (1963) and Bohm (1971). The focus of the study was to investigate the impacts of Navajo coal strip mine and the Four Corners electric generating plants in the Southwest region. Specifically, aesthetic benefits of abatement of environmental damage resulting from air pollution (visibility), power lines and land disturbance from mining activities were estimated. As such, the study laid the framework for future contingent valuation studies.

The analysis focused on the design of survey instruments exploring alternative mechanisms within the instruments for eliciting willingness to pay. No bias tests (i.e., hypothetical, information, instrument, interviewer, non-respondent sampling bias tests) were formally reported.

The Lake Powell Experiment[10]

Lake Powell, with an annual visitation now approaching two million visitor days, is an excellent example of the tradeoff between preservation and development. The lake was formed by the filling of Glen Canyon but retains the steep cliffs, rugged terrain features, and scenic vistas one associates with the Grand Canyon, and is now accessible to pleasure boaters and other recreators. Construction of the Navajo coal-fired generating station located at the southern end of Lake Powell was completed in 1976. Another larger plant, the Kaiparowitz Project, was also proposed for construction near Lake Powell and became an issue of substantial public concern.

As part of the Lake Powell experiment, during the summer of 1974, recreators at Lake Powell were interviewed in an attempt to determine the aggregate willingness to pay to prevent construction of the proposed Kaiparowitz plant [See Brookshire, et al. (1976)]. Photographs of the existing Navajo power plant which all of the recreators had seen stacks remain visible more than 20 miles up the lake were shown to recreators both with visible pollution emanating from the stacks and with the stacks alone. Recreators were then asked what entrance fee they would be willing to pay to prevent construction of another similar plant, first, where only pollution would be visible from the lake itself, and second, where both stacks and pollution would be visible.

The analysis of the data focused on strategic bias. As noted above, if recreators believed that a uniform entrance fee might actually be set on the basis of the average bid of the sample to prevent construction or believed that construction plans might be affected by the research results, then "environmentalists" might well bid very high, and "developers" might well bid zero dollars in an attempt to bias the results.[11] A theoretical model of strategic bias was constructed to explain the distribution of observed bids

which would likely be bimodal rather than normally distributed if strategic bias was present. The fact that the actual distribution of bids was normally distributed was thus taken as evidence that strategic bias was not present. It was suggested by Brookshire, et al. (1976), that the absence of strategic bias might be due to the hypothetical nature of the experiment--few respondents felt that their answers would affect real world outcomes.

Hypothetical, information and instrument bias were not addressed in this experiment. Experimental biases such as interviewer, non-respondent bias and sampling bias did not appear significant. The interviewers taken separately had means and a distribution of bids that corresponded to the sample population as a whole. In sampling which was randomly conducted for the four principal users of Lake Powell, on the lake, in campgrounds, at motels and in the town of Page, the highest refusal rate for residents was less than one percent.

The remainder of the research was devoted to specifying an econometric model of the bidding game results to estimate income effects by groupre- creators were divided into four categories, developed and remote campers, and visitors to and residents of the nearby town of Page, Arizona. Although the effect of individual income by group on bids was statistically significant at least 99% level, the income effects were all very small. It was demonstrated that both theoretically and empirically the small income effect implied: (1) that a compensated surplus measure would not differ practically from the equivalent surplus measure used in the experiment; and, (2) that income redistribution between groups would not significantly affect the aggregate bid.

The average bid per family or recreator group was $2.77 in additional entrance fees in 1974 dollars, and the total annual bid--which can be interpreted as an aggregate marginal willingness to pay to prevent one additional power plant near Lake Powell--was over $700,000. An important point is that the results show impressive consistencies both with the one previous study [Randall, et al. (1974a)] in the region as well as with the succeeding Farmington experiment discussed below.

The Farmington Experiment[12]

This study reported in Blank, et al. (1977) and Rowe, et al. (1980) attempted to establish the economic value of visibility over long distances for Farmington residents and recreators at Navajo Reservoir. Clearly, the ability to observe long distances is almost a pure public good. In addition, efforts were made to examine the extent of certain biases which the Brookshire et al. (1976) study identified. These were information, strategic, starting point, and instrument biases on compensating and equivalent surplus measures

of consumer surplus.

Recreators and residents in the Four Comers Region of New Mexico and Arizona were interviewed. The interviewee was shown a set of pictures depicting visible ranges. Picture set C had a visible range of 25 miles and picture sets B and A were 50 and 75 miles respectively. The pictures represented views in different directions from the same location, the San Juan Mountains and Shiprock.

The first part of the experimental bidding game was structurally similar to that of Randall, et al. (1974a,b) and Brookshire, et al. (1976). A sequence of questions on maximum willingness to pay and minimum compensation were asked via a survey instrument. The second method followed that of Rosen, (1974), Muellbauer (1974), and Hori (1975) in attempting to utilize the household production function. The motivation was to attempt a methodological cross check by collecting market type information via a survey instrument. The contingent behavior component of the questionnaire attempted through contingent changes in time allocation to infer an expenditure function and compensated demand curve, primarily by postulating an exact form of a utility function and estimating a time related household technology [Blank, et al. (1977)]. Thus, the first approach bidding game was an attempt to measure the right-hand-side of equation (4), while the second contingent behavior based on contingent behavioral changes, attempts to measure the components of the right-hand-side of equation (5). These estimates from the contingent bidding and contingent behavior portions of the experiment are not directly comparable because the contingent behavior estimates include residents in addition to recreators which should increase the magnitude of the estimate.

As part of the contingent bidding approach, direct tests were made for strategic bias, information bias, and instrument bias. First, for strategic bias investigation, the survey instrument was structured so the individual was told that he would have to pay the "average" bid, not his own.[13] The presumption was that if his bid were below the mean bid provided by the interviewer and he desired to increase the magnitude of the final aggregate bid strategically, he would bid higher in order to shift the final bid upward. Alternatively, if his goal in bidding strategically was to reduce the final mean bid, he would revise his bid downward. Only in the unlikely case when the individual's maximum bid is identical to the mean bid would there be no incentive for the individual to change. In only one case was an individual observed acting strategically and he turned out to be an economics professor from the local Junior College! This additional indication along with the results of Brookshire, et al. (1976) suggests that individuals generally do not act strategically, at least in a meaningful manner to bias the outcome of the results.

For information bias, it was suggested to the individual that his or her bid was too low--that the bid was not sufficient to keep power plant emissions at present levels for sustained high quality ambient air. The individual was then asked if he or she would revise the bid. Fully one-third revised their bid when confronted with the possibility that their bid was insufficient. This latter result is indicative of the effect that new information possibly has on bidding behavior.

Analysis was made of various forms of instrument bias, essentially trying to establish influences of various aspects of the contingent market structure. It was observed that the higher the starting bid suggested by the interviewer, the higher the maximum willingness to pay (equivalent surplus) estimates derived from the study. Thus, if the interviewer suggested a bid of $1.00 higher, on the average, individuals would "bid" about $.60 more. Also, the choice of method of payment influenced the magnitude of the bid significantly. Individuals were willing to bid higher when confronted with a "payroll tax" than with an increase in entrance fees. Finally, it was observed that whether or not the individual was given previous information on average bids, has a substantial impact on the maximum bid. We do not wish to suggest these results indicate any final conclusions with regard to the information bias problem with the contingent valuation approach, but they are suggestive that for these approaches to be accurate, one must be very careful with the instrument used for payment and the amount and quality of information given to the interviewee upon initiation of the interview.

Other potential biases--sampling, non-respondent bias and interviewer bias--are also of interest. The sample design attempted a stratified sample with respect to household income, ethnic background, age, sex and resident/nonresident. After identifying neighborhoods with certain characteristics and times of day appropriate for finding males and females at home, two approaches were utilized in obtaining interviews: randomly going door to door and telephoning to set up an interview time. A significant non-respondent bias might exist for the Farmington resident interviews. Up to 75% of the phone call requests for an interview were rejected and up to 50% of the door to door requests were declined. However, for the recreators' interviews at Navajo Reservoir, less than 5% of the requests for interviewing were declined. Why this disparity for responses between residents and recreators is not known. Finally, no records were kept that would enable an investigation of interviewer bias.

It is interesting to compare results of the Farmington study with previous studies. Randall, et al. (1974a) only reported, and Brookshire, et al. (1976), only obtained equivalent surplus bids. The following comparisons which are presented in Table 1, are, therefore, limited to the equivalent

Table 2.1

COMPARISON OF RESULTS FOR SOUTHWEST VISIBILITY STUDIES[a]

Non-Market Valuation Studies	Public Good	Vehicle Employed	Yearly Mean Bids		Bid Per Day
1. Four Corners Experiment (A. Randall, et. al., 1974a,b)	Visibility Spoil banks transmission lines (Aesthetics of the above.)	Sales Tax	$85[e] [4,3119	$50 [3.02]	(N/A)[f] ($1.79)[d] [.19]
2. Lake Powell Experiment (D. Brookshire, et. al., 1976)	Visibility (Aesthetics only)	Access fee	N/A	N/A	$2.95[b] ($1.52) [.20] [.29]
3. Farmington Experiment, (F. Blank, et. al., 1977 and Rowe, et..?]. , 1980)	Visibility (Aesthetics only)	utility bills or wage tax	$82 [9.10]	$57 [4.63]	$2.44[c] (N/A) [.23]

[a]The Four Corners Experiment and the Lake Powell Experiment only obtained equivalent surplus bids, thus comparisons between studies are limited to sub-samples of the data sets from each study.

[b]Adjusted for 6.6% inflation.

[c]Mean bid for $1.00 starting points in the Farmington Experiment which is the starting point used in the Lake Powell Experiment.

[d]The comparison between the Four Corners Experiment and the Lake Powell Experiment required different comparisons with the Farmington Experiment.

[e]The comparisons between the Four Corners Experiment and the Farmington Experiment is for two alternative levels of environmental quality changes.

[f]N/A - No comparison can be constructed.

[g]Standard errors in [ ].

surplus bids. Using the sales tax as the instrument, Randall, et al. (1974a), reported yearly mean bids of $85.00 [$4.31][14] for moves from the highest level of environmental damage, situation (A), to situation (C) representing lowest levels of environmental damage; situation (B) represented an intermediate level of damage. A yearly mean bid of $50.00 [$3.02] per household was reported for moves from situation (B) to situation (C). The Farmington experiment yearly mean bids for the most comparable situations were $82.20 [$9.10] and $57.00 [$4.631. If one considers that the Randall, et al. (1974a) figures should be higher as respondents are also bidding on soil banks and transmission lines, these figures are comparable.

The overall mean for situation (A) (good visibility) to (C) (poor visibility) in the Lake Powell Experiment, [Brookshire, et al. (1976)], was $2.77 [$.19] per day. Adjusted for the 6.6% inflation between the time periods of the studies, these values become $2.95 [$.20]. The overall mean for recreationists for the comparable situation in the Farmington Experiment was $4.06 [$1.111, which is considerably different. However, the mean bid was $2.44 [$1.23] when $1.00 starting bids were used in the Farmington Experiment, which corresponds to the Lake Powell starting bid. Thus, while still statistically different, for the same starting bids, the results are much closer. The Farmington Experiment, while not designed as a replication, demonstrated reasonable consistency with other studies. Finally, a comparison of values for similar subsamples between the Four Corners and the Lake Powell Experiments, respectively of $1.79 [$.19] and $1.52 [$.29], also suggest consistency.

The Geothermal Experiment[15]

The Jemez Mountains of New Mexico are both scenic--characterized by colored rock outcropping and forest areas--and a major recreation resource with fishing, campgrounds, hiking trails, and hot springs all located on U.S. Forest Service lands. However, the Jemez Mountains also contain one of the major geothermal resources in the Southwest. Geothermal leases have been let by the U.S. Forest Service on land which is now used solely by recreators.

Both a contingent bidding and a contingent site substitution approach were used to estimate environmental damages to recreators from possible geothermal development [Thayer (forthcoming)]. Recreators were shown both photographs of geothermal development in similar mountainous terrain and a map of the location of possible development relative to recreation areas. Noise levels and emission characteristics were described in detail. A bidding game was then conducted using a uniform entrance fee as the vehicle to prevent development. Additionally, respondents were asked to indicate what their contingent recreation plan would be (what sites would they visit including new

substitute sites and how often) if development were to occur. The subsample which responded to the site substitution question, was then also asked what they would bid in the form of a uniform entrance fee to prevent development. Finally, starting point for the bidding game was varied from $1.00 to $10.00 in various subsamples. Thus, the study was structured to test: (1) if contingent bidding and site substitution results were consistent; (2) if information on alternative new substitute sites would affect bidding results; and (3) for starting point bias.

A set of theoretical models were constructed to estimate a consistent measure of willingness to pay to prevent development from two measures: (1) the contingent valuation bidding and; (2) additional travel costs associated with alternative recreation plans. This was an attempt at a methodological cross check.

The interviews were conducted randomly amongst recreators in the Jemez area. It is not known if this resulted in sampling bias. A simple distributional analysis of the data indicated no interviewer bias.

More surprising, however, were the results for information and starting point bias experiments. Neither bias was statistically significant. The obvious question is: Why are these results different from those of the Farmington Experiment, which indicated that both information and starting point would likely be serious problems? The best explanation that can be given at this point is that the value of the change in environmental quality proposed in the two studies was more precisely perceived by respondents in the Geothermal Experiment than in the Farmington Experiment. In other words, respondents could more easily relate the costs to themselves of "losing," in part a recreation area than they could determine the costs of a change in visibility.

The results of the experiment were as follows: thirty-two percent of the respondents indicated they would no longer visit the Jemez area if development occurred. This resulted in about a 40% contingent decrease in visitation. About 65% of the respondents indicated they would visit alternative sites more frequently, usually the Pecos Forest area. Bids averaged $2.54 per visitor party day while the site substitution measure yielded a range of $1.852.59 depending on the assumed driving cost per mile. The results appear to be consistent for the two approaches and imply an annualized aggregate bid to prevent construction of about $300,000 for a 50 megawatt plant.

The Wildlife Experiment[16]

Through contingent bidding and site substitution approaches, this study

attempted to develop a methodology for valuing wildlife experiences. The valuations were developed to enable policymakers to judge which sites should be reserved from energy developments so that energy development would not seriously impinge on wildlife. Hunters and wildlife observers were queried as to their willingness to pay for "encounters" with various types of wildlife. Encounters was chosen as the variable of perturbation. The hypothesis was that the more animals sighted the greater the satisfaction from the hunting experience.[17] The species examined were elk, cottontail, coyote, grizzly bear, bighorn sheep, trout, dipper, and brown creeper. The assumed utility function had as arguments the number of encounters and length of activity. Thus, the study attempted to measure both the left and right-hand-side components of equations (4) and (5). Prices for purchase of private goods for the hunting, fishing, or observation experience were presumed to be constant, which appears, except for inflationary factors, to be a reasonable assumption. A wide variety of surveys were tested utilizing alternative formats and structural components.

A type of instrument bias was observed in that bids were recorded through license fees, access fees, and utility bill adjustments, but difficulties were encountered in convincing some respondents that competition between energy development and wildlife herds would be sufficient reason for utility bill adjustments. Starting point bias was tested for, but was not found to substantially affect the bids on species commonly hunted. Thus, this experiment appears to substantiate the comparison between the Geothermal and Farmington Experiments which led us to propose that the more clearly identified the change in the environmental attribute is, the lower the probability of starting point bias.

Sampling was carried out in Laramie, Wyoming, drawing from hunting and fishing license lists provided by the Wyoming Game and Fish Department. Addresses were drawn randomly from the lists. Refusals by individuals to actually participate in all parts of the study was about 9%.

Interviewer bias was not present at the .05 level of significance. Nonresponse rates to individual bidding games where an individual permitted an interview but refused to play a particular bidding game under the stated rules ranged from 2% for willingness to pay games to 30% for some willingness to accept compensation games.

Results indicate that, for elk, the average willingness to pay equivalent surplus measure is $54.00 per year to increase expected encounters (i.e. , sightings) from 1 to 5 per day for elk hunting in Wyoming. The average willingness to accept compensating surplus measure for a reduction of 5 to 1 encounters per day of elk was $142.00. Some private clubs which specialize in

elk hunting in Wyoming charge entrance fees ranging from $85.00 to $150.00 per year, roughly in the range of the compensating surplus measure for elk encounters obtained though the contingent valuation approach.

Before turning to the last case study, we would like to discuss an issue that has arisen in empirically implementing contingent bidding games. The issue that continually arises is the observed differences between willingness to pay (WTP) and willingness to accept (WTA) measures of welfare change. Willig (1976) derived conditions that suggest upper and lower bounds exist between the measures.[18] However, Gordon and Knetsch (1979) suggest that WTP and WTA differentials are, in fact, substantial. Empirically to date the results have been mixed. In the Four Corners Experiment [Randall, et al. (1976b)] it was noted that "the number of 'infinity' responses is striking" and that WTA answers "generally exceeded the willingness of respondents to pay for environmental improvement." It is suggested that this was not indicative that no amount of compensation was sufficient, but that abatement by the energy industry might be preferred. The Lake Powell Experiment [Brookshire et al. (1976)] derived a WTA measure from WTP responses and found the measures to be close. The Farmington Experiment [Blank, et al. (1977) and Rowe, et al. (1980)] again directly asked compensating measures, finding the WTP and WTA measures statistically different. Over 50% of the respondents in the Farmington study either refused to cooperate or bid infinity. Finally, the Wildlife Experiment [Brookshire, et al. (1976) and Brookshire, et al. (1980)] utilized different formats for obtaining WTP and WTA measures of consumer surplus. Again the results were statistically different. However, when the WTA measures were derived, similar in context to Brookshire, et al. (1976) the values were statistically the same.

What conclusions and explanations can be given for the above results? Differences between a WTP and WTA welfare measures potentially could be due to income constraint consideration, differing property rights structures, failure of the respondent to relate and be able to respond to the contingent market presented, and/or protest "votes" based on ethical considerations. To date, we know of no experiment that has been performed to attempt an explanation or identify which of the above reasons might be correct.

The South Coast Air Basin Experiment[19]

In some Los Angeles neighborhoods, deterioration in air quality has been slight, e.g. , communities adjacent to the Pacific Ocean, while in others, the deterioration has been relatively severe, as measured by concentrations of NO_X or total oxidants.

The previous case studies reported here, while internally consistent,

failed to provide a methodological cross check to actual market data. This experiment, in contract, attempted to compare both the left-hand-side (contingent bid) and right-hand-side (hedonic measure of equation (8)). Thus, both a traditional property value study and a contingent valuation were conducted in an attempt to determine if people will actually pay (as exhibited by property values) what they say they are willing to pay. Finally, site substitution information pertaining to activities, location, duration, frequency and expenditures was collected as well.

A shortcoming of the visibility case studies discussed earlier was the potential confounding between health effects of air pollution and aesthetic effects. The contingent bidding and substitution approaches employed in this experiment attempted to value each of these components separately. Aesthetic considerations were represented by alternative levels of visibility, acute health effects by eye irritation and chronic health effects by reduction in life span. Additionally, the population of the South Coast Air Basin has become well informed through the years of the causes of air deterioration, the potential effects, and scope of the problem. Thus in valuing the non-market good, "air quality," the experiment was conducted with reasonably well developed market information for individuals.

In order to insure comparability of results and aid in aggregation, six pairs of neighborhoods were selected at the census tract level. The pairings were made on the basis of similarities of housing characteristics, socioeconomic factors, distance to beach and services, average temperature, and subjective indicators of the "quality" of housing. Thus, for each of the six pairs, an attempt was made to exclude effects on property values of factors other than differences in air quality. Each of the methodologies were implemented in the paired areas. The bidding game was conducted by randomly choosing homes within the paired areas. The air quality levels for the paired areas were determined using monitoring station data in the South Coast Air Basin. Focusing on total oxidants, nitrogen dioxide and total suspended particulates, isopleths were constructed for each pollutant. This allowed "good," "fair," and "poor" air quality regions to be designated for purposes of the experiment.

The data for the property value study, obtained from the Market Data Center,[20] pertained to 719 homes sold in the 12 paired communities from January, 1977 to March, 1978 (note the interviewing was conducted during the latter part of this time interval) and contains information on most important structural and/or quality attributes. Thus, the data was micro level in detail and yielded valuation estimates at the household level. The property value analysis encompassed three separate, and increasingly complex approaches. First, a comparison of average housing values in the sample paired

communities, standardizing only for living space was conducted. Second, a linear relationship between a home's sale price and its supply of housing and community attributes was estimated. The value of an improvement in air quality was then deduced from the resulting hedonic housing value equation. Third, following Harrison and Rubinfeld (1978), a hedonic housing equation allowing for nonlinearities was estimated from which the willingness to pay equation, as a function of income and other household variables, was again estimated. This last procedure partly overcomes some of the strict assumptions of the more simplistic approaches such as identical preferences of all individuals.

The contingent bidding and site substitution data of the experiment were collected via a survey questionnaire. The survey questionnaire yielded valuations by individual for aesthetic and health effects. The survey questionnaire was designed to test for strategic, information and starting point biases. The postulated change in air quality was represented both through regional maps showing good, bad and fair air quality areas as-well as by photographs showing typical visibility levels. Two specific forms of information bias were investigated via a health pamphlet. The health pamphlet attempted to determine for a subsample of the respondents if detailed information about health effects would affect bidding and substitution behavior. Strategic (as in Brookshire, et al. (1976)), information and instrument bias were not statistically significant influences upon the results. Also interviewer bias was not present. No records were kept that would enable the testing for nonrespondent bias.

Accounting for factors such as distance to beach and differences in preferences, the property value study gave an estimated average bid of $40.00 per month per household for a 30% improvement in air quality. The bidding results gave an average bid of slightly less than $30.00 per month. Thus, reasonable comparability was obtained between the survey and property value estimates. Given various assumptions of location, income, aggregation by areas, specific housing characteristics and knowledge on health effects of air pollution, both the bidding game and property value studies yielded estimates ranging from $20.00 to $150.00 per month per household for a 30% reduction in air pollution. These results indicate that air quality deterioration in the South Coast Air Basin has had substantial effects on housing prices and that these negative price effects on housing are comparable in magnitude to what people say they are willing to pay for improved air quality.

CONCLUSION

The six case studies summarized above have shown some consistency in results and hopefully further the evaluation of problems in structuring

contingent market experiments.

Table 2 presents a brief summary of the characteristics of each experiment. The range of environmental attributes valued is quite large--including visibility, wildlife, health and noise. Four out of six attempted some internal methodological cross check, however, only the South Coast Air Basin Experiment utilized an observed set of market prices for the comparison. Biases do not appear to be an overriding problem. Strategic bias was not observed in any experiment. Vehicle and starting point biases were highly significant in the Farmington Experiment. Starting point bias was not found in any other study. Vehicle bias was significant in the Wildlife Experiment. A probable explanation for these results, which offers advice for future experiments, is that the linkage within the contingent market between the environmental attribute, institutional setting and the bidding instrument must be realistic and be accepted by the respondent or biased results will be obtained. The studies further indicate the need to establish a precise contingent market--the "good" must be well defined.

Possibly the most important result of the studies summarized here is the replication of results utilizing a traditional property value study and a contingent bidding approach. At least for this first test case, individuals do appear to provide contingent valuations comparable to what actual market behavior implies they are willing to pay for an environmental attribute.

Finally, the studies reviewed in this paper are part of what has become an ongoing research tradition. It is thus worthwhile to place these efforts in the context of other recent comparable research. First, both the experimental research reported by Grether and Plott (1979) and that reported by Smith (1977) supports the general conclusion that strategic bias in revealing consumer preferences is not likely to be a major problem. Second, a rather different attempt at validation of a survey approach has recently been conducted by Bishop and Heberlein (1979). A market for repurchasing hunting permits was structured in a "bidding context" and the results are compared to a traditional travel cost methodology. Since no similar efforts have been undertaken utilizing mail surveys and repurchasing plans, the research is not directly comparable to that reported here, Bishop, et al. conclude, somewhat pessimistically, that since their survey approach might overvalue or undervalue goose hunting permits by as much as 60 percent and 55 percent respectively, while the travel cost methodology undervalues by 67 percent, that all of the available techniques show considerable bias and are thus of limited use. We, rather, take an opposing position, and view these results as quite encouraging for the following reason: In many cases, decisionmakers quite simply have absolutely no idea as to the economic value of preserving environmental quality. All evidence obtained to date suggests that the most

Table 2.2
OVERVIEW OF NON-MARKET
VALUATION EXPERIMENTS

Non-Market Valuation Studies	Environmental Attribute Being Valued	Location	Methodological Cross Check	Strategic Bias	Instrument Biases		Information Bias
					Vehicle Bias	Starting Point Bias	
1. Four Corners Experiment (A. Randall, et. al., 1974).	Visibility, spoil banks, transmission lines.	Four Corners Area, South West.	No	N/A[a]	N/A	N/A	N/A
2. Lake Powell Experiment (D. Brookshire, et. al. 1976).	Visibility	Four Corners Area, South West.	No	No	N/A	N/A	N/A
3. Farmington Experiment (F. Blank, et.al., 1977 and Rowe et.al., 1980).	Visibility	Four Corners Area, South West.	Yes	No	Yes[c]	Yes[c]	Yes[c]
4. Geothermal Experiment (M. Thayer, et. al., forthcoming).	Noise, Land Disturbance	Jemez Mountains.	Yes	No	N/A	No[d]	No[e]
5. Rocky Mountain Wildlife Experiment (D. Brookshire, et. al., 1577 and forthcoming).	Encounters with wildlife	Wyoming	Yes	No	Yes[f]	No[f]	N/A
6. South Coast Air Basin Experiment, (D. Brookshire, et. al., 1980).	Visibility, health Effects	Los Angeles Region, California	Yes	No	No[g]	No[g]	No[h]

[a] Not Available - The experiment did not consider either structurally or analytically this form of bias.
Strategic bias tests were defined in Brookshire, et.al. (1976).
[c] Utilizing estimated bid curves the t ratios for these variables were respectively (3.05), (7 98) and (-4.54) where the vehicle variable was O = utility bill, l= payroll deduction; starting bid variable was either $l, $5, or $10 and information variable was 0 = no prior information, 1 = prior information. See Rowe, et.al. (1980).
[d] Utilizing an estimated bid curve the t ratio was .689 on the starting point variable indicating no significant influence.
[e] Information bias in this study pertained to whether the suggestion of alternative recreation cities would influence the bid.
[f] A standard F-test was utilized with no statistical influence being observed.
[g] A T-test was conducted where the hypothesis that the final value data was influenced by the bidding vehicle (starting bids) was rejected.
[h] A T-test was conducted whereby the acceptance of the hypothesis that the mean bids for all paired areas combined for different bidding vehicles (starting points) are equal implies l-α=.90 and higher.
Information bias in this study related to alternative sequencing of health and aesthetic information. The test was as in footnote e.

readily applicable methodologies for evaluating environmental quality--hedonic studies of property values or wages, travel cost and survey techniques--all yield values good to well within one order of magnitude in accuracy. Such information, in our view, is preferable to complete ignorance.

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1. Maler (1974) has classified the possibilities for measurement of environmental goods or services into four broad categories: (1) asking individuals what they are willing to pay; (2) voting on the supply; (3) indirect methods based on observations on the relationship between private goods purchased and environmental goods; and (4) estimation of physical damage and evaluation on the basis of observed market prices. In this paper, we analyze methods only within Maler's categories (1) and (3).

2. In the recent literature, one approach within this set has been called "bidding games," [Randall, et al. (1974a); Brookshire, et al. (1976)]. However, because some types of responses are not bids but changes in behavior, e.g., site substitutions or minimum compensation, we prefer the more general "contingent valuations" to identify the set of approaches that directly query the individual for information in a series of hypothetical situations on markets.

3. An alternative listing of explanations for bias and other problems is given in D. Grether and C. Plott, (1979).

4. A detailed form for the utility function compatible with our arguments is $U(G_1(Q_1, A_1), G_2(Q_2, A_2), \ldots; X)$. The G_i can be concave increasing functions for each activity and imply the utility function is weakly separable over locations or activities.

5. This is equivalent to the compensating variation measure of consumer surplus where the initial level of utility is maintained. See, for example, Mishan (1971).

6. See Brookshire and Crocker [forthcoming (b)] for a discussion of the role of information in contingent markets and validity of the consumers response.

7. One survey of air pollution in the late 1960's for Los Angeles which we prefer not to cite asked the question "How much are you willing to pay for less air pollution?" Clearly, this question is too vague and subject

to multiple interpretations as to the change in environmental attribute. Alternatively, a question "How much are you willing to pay for an annual average reduction in oxidant concentrations of .10 parts per million in the seven block radius around Hollywood Boulevard and Vine Street?" may be too specific and not readily understandable by the interviewee. There appears to be a fine line where the general public can fully understand the question posed, yet the question is precise enough to be of scientific usefulness, i.e., be relatable to scientific measures of environmental change.

8. See Brookshire and Crocker [forthcoming (b)] for further discussion.

9. We present this extremely brief summary of Randall's work noting it was the first effort, and to set the stage and focus the discussion for the remaining case studies. See Randall et al. (1974a,b) for a complete discussion of the results.

10. This research was funded by the NSF-RANN Lake Powell Research Project.

11. The average bid concept was introduced in the survey instrument in the following manner; "Let's also assume that all visitors to the area will pay the same daily fee as you . . . ." The use of the terms "environmental" and "developers" is to distinguish two groups who might have widely divergent preferences with respect to environmental commodities.

12. This study was supported by the Electric Power Research Institute (EPRI), Palo Alto, California to the University of Wyoming. EPRI does not assume any liability for the completeness of research, or usefulness of the results.

13. For individuals to bid strategically to achieve a specific outcome when the respondent knows everyone must pay the final bid is extremely difficult. For instance, all previous bids by others must be known, the sample size and if the individual is not the "last" bidder, then future bids must be known. For more discussion see Brookshire and Eubanks [forthcoming (a)].

14. Standard errors in brackets. 15. The research reported here was supported by a NSF grant entitled "An Economic and Environmental Analysis of Solar and Geothermal Energy Sources."

16. Portions of this study were funded by the U.S. Fish and Wildlife Service contract numbers 14-16-0009-77-022 and 14-16-0009-77-003 with the University of Wyoming and parts were sub-contracted to the University of

Kentucky.

17. For a complete discussion of the study see Brookshire, et al. (1977) and Brookshire, et al. (1980).

18. Randall and Stoll (1979) have reformulated Willig's results from price to surplus space.

19. This study was supported by the U.S. Environmental Protection Agency EPA-600/6-79-OOOlb.

20. The Market Data Center is a computerized appraisal service centered in Los Angeles, California.

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